RECONNAISSANCE OF SELECTED ORGANIC CONTAMINANTS IN EFFLUENT AND GROUND WATER AT FIFTEEN MUNICIPAL WASTEWATER TREATMENT PLANTS IN FLORIDA, 1983-84

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CONVERSION FACTORS

For use of readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply inch-pound units	By	To obtain metric (SI) units
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
million gallons per day (Mgal/d)	0.0438	cubic meter per second (m^3/s)

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Temperatures are converted from degrees Celsius (°C) to degrees Fahrenheit (°F) by the formula °F = 1.8 x °C + 32.

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ABSTRACT

Results of a 1983-84 reconnaissance of 15 municipal wastewater treatment plants in Florida indicated that effluent from most of the plants contains trace concentrations of volatile organic compounds. Chloroform was detected in the effluent at 11 of the 15 plants and its common occurrence was likely the result of chlorination. The maximum concentration of chloroform detected in the effluent sampled was 120 micrograms per liter. Detectable concentrations of selected organophosphorus insecticides were also common. For example, diazinon was detected in the effluent at 12 of the 15 plants with a maximum concentration of 1.5 micrograms per liter. Organochlorine insecticides, primarily lindane, were detected in the effluent at 8 of the 15 plants with a maximum concentration of 1.0 micrograms per liter.

Volatile compounds, primarily chloroform, were detected in water from monitor wells at four plants and organophosphorus insecticides, primarily diazinon, were present in the ground water at three treatment plants. Organochlorine insecticides were not detected in any samples from monitor wells. Based on the limited data available, this cursory reconnaissance suggests that the organic contaminants commonly occurring in the effluent of many of the treatment plants are not transported into the local ground water.

INTRODUCTION

Land application of effluent is a widespread method of municipal wastewater disposal and reuse in Florida. As of January 1980, more than 2,500 wastewater disposal plants in Florida were classified as using one or more land-application techniques (Franks, 1981, p. 12). About 70 percent of the disposal plants use infiltration ponds, 20 percent use drain fields, and 10 percent use spray irrigation. Collectively, these 2,500 disposal plants apply about 150 million gallons per day of treated wastewater to the land surface throughout Florida. Many land application plants are located near high population areas where surficial aquifers are an integral part of the public water-supply system. Thus, the disposal of large quantities of wastewater, though treated, has the potential to adversely affect the integrity of public water-supply systems.

Because land application of effluent may adversely impact public water supplies, the State of Florida requires periodic chemical analysis of both the effluent and water from monitoring wells at these disposal plants (Florida Department of Environmental Regulation, 1983). A critical concern is the lack of data on the organic composition of effluent and local ground water at these land-application plants.

Purpose and Scope

The purpose of the study was (1) to determine the presence and concentration of organic contaminants in effluent and local ground water at 15 municipal wastewater treatment plants in Florida that use land-application methods of disposal, and (2) to determine if organic contaminants from the effluent may be contributing to ground-water contamination in the immediate vicinity of the disposal plants.

This report describes the design of the two-phase reconnaissance program and discusses the analytical results. The scope of phase I (April through August 1983) included the sampling of effluent for organic analysis from holding ponds, percolation ponds, discharge pipes, and sewage outfalls at the 15 wastewater treatment plants. During phase II (October through December 1983), samples of the effluent and water from a monitoring well downgradient and adjacent to the land application area at each plant were collected for selected organic analyses.

Previous Studies

Few Florida studies have reported on the contribution of effluent to organic contamination of ground water at land-application plants. In 1983, Yurewicz reported results from organic analyses of samples collected from 1972 through 1978 at 10 observation wells at sites in a spray field southwest of Tallahassee (fig. 1). Results of all analyses for chlorinated insecticides, chlorophenoxy acid herbicides, polychlorinated biphenyls, and polychlorinated naphthalenes were below minimum detection limits.

In a Michigan study (Dunlap and others, 1977) at a Muskegon County rapid infiltration plant, 59 organic contaminants were detected before waste treatment, 19 after lagooning, and only 8 in the final effluent after irrigation. This plant used tiles to underdrain the system so the runoff from the irrigation was collected and pumped into a nearby creek with minimum effect on the associated ground water. At most rapid infiltration plants, influent water percolates down to the ground-water aquifer or evaporates to the atmosphere.

Researchers at a rapid infiltration site in Phoenix, Ariz., assessed the effectiveness of the removal of trace level organics from wastewater by analyzing treated effluent and soil cores from the infiltration basins and ground water from monitoring wells (Tomson and others, 1981). Recognizing that adsorption, volatilization, and biodegradation are the three major mechanisms for compound removal, the study reported that removal efficiencies vary

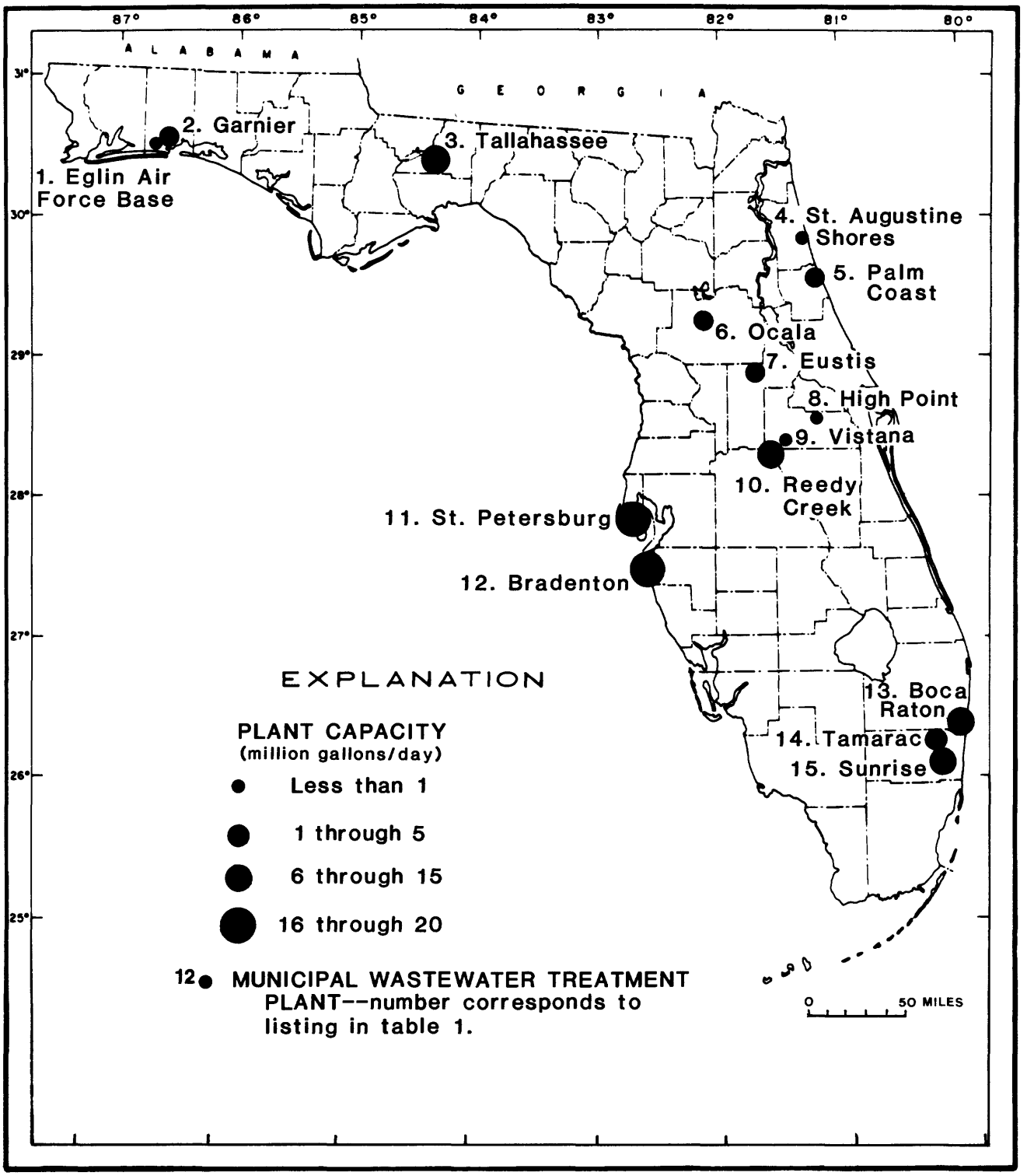

Figure 1.--Locations and capacities of municipal wastewater plants sampled.

from 70 to 100 percent depending on the group of organic compounds detected. Concentrations of refractory organic compounds in the treated effluent ranged from 0.008 to 2.140 micrograms per liter (µg/L) and from 0.002 to 0.729 µg/L in the ground water. Among the 67 compounds detected were trichloroethylene, tetrachlorethylene, toluene, chlorobenzene, xylenes, dichlorobenzenes, cresols, and phthalates.

In Roswell, N.M., a slow-rate irrigation site was investigated for a period of one year to determine the long-term effects of land application of municipal wastewater (Koerner and Haws, 1979). The authors concluded that none of the pesticides endrin, lindane, methoxychlor, and toxaphene, nor the herbicides 2,4-D and silvex were found in the irrigation effluent or in the ground water in concentrations greater than the established maximum contaminant levels (MCL) specified by the National Interim Primary Drinking Water Regulations.

Acknowledgments

This study was conducted by the U.S. Geological Survey in cooperation with the Florida Department of Environmental Regulation. The authors gratefully acknowledge the assistance provided by each plant superintendent, plant operator, and other plant staff members.

DESCRIPTION OF STUDY

A description of the 15 municipal wastewater treatment plants selected for study are shown in figure 1 and table 1.

Plant Selection

The plants were selected using the following criteria:

1. The plant used land application of effluent for more than 5 years;

2. Preference was given to land application plants that were located in areas where the surficial aquifer is used as the primary or secondary source of public water supply;

3. The land application plant had a monitoring well network; and

4. Large capacity plants were given preference over smaller capacity plants because these plants were thought to be more representative of the organic quality at other wastewater-treatment plants in Florida. However, in order to ensure statewide coverage, four plants serving a population of less than 10,000 were included in the reconnaissance.

Table 1.--Description of municipal wastewater treatment plants sampled

Plant No.	Facility	First year operated	Design capacity, Mgal/d	Population served	Type of treatment	Type(s) of disposal	Interim storage	Monitoring network at disposal site
1	Hurlburt Field Water and Waste Plant, Eglin AFB	1955	0.7	10,000	Trickling filter (multipass)	Spray irrigation	Asphalt or plastic lined holding ponds	10 wells
2	Garnier Beach Sewage Treatment Plant	1972	5	33,000	Contact stabilization	Spray irrigation	Asphalt lined holding ponds	9 wells & Timberlake pond
3	Tallahassee Thomas P. Smith Waste Water Renovation Plant	1966	10	100,000	75% activated sludge, 25% trickling filter	Spray irrigation	Lined holding ponds	60 wells
4	St. Augustine Shores Wastewater Treatment Plant	1971	.3	5,000	Extended aeration (package plant)	Spray irrigation, percolation	Percolation pond	2 wells
5	Palm Coast Utility Corp.	1979	1.6	8,000	Extended aeration	50% spray irrigation, 50% percolation	Three-tiered percolation pond	6 wells
6	Ocala Wastewater Plant No. 2	1972	2.2	20,000	Contact stabilization	Percolation	Percolation ponds	6 wells
7	Eustis Sewage Plant	1951	1.1	11,000	Trickling filter	75% spray irrigation, 25% percolation	Percolation pond	10 wells and 2 ditches
8	High Point Wastewater Treatment Facility	1962	.2	100	Activated sludge	Spray irrigation, percolation	Limerock lined holding ponds	8 wells
9	Vistana Wastewater Treatment Facility	1977	.7	7,000	Activated sludge	Percolation	Percolation pond only	3 wells

Table 1.--Description of municipal wastewater treatment plants sampled--Continued

Plant No.	Facility	First year operated	Design capacity, Mgal/d	Population served	Type of treatment	Type(s) of disposal	Interim storage	Monitoring network at disposal site
10	Reedy Creek Improvement District	1971	6	70,000	Activated sludge	15% spray irrigation, 85% percolation	Holding pond for tree farm spray irrigation	15 wells
11	St. Petersburg Northwest No. 3 Wastewater Plant	1974	20	64,000	Activated sludge	80% transported to Bay or deep-well injection, 20% spray irrigation[1]	Effluent holding tank	8 wells
12	Southwest Regional Treatment Plant, Bradenton	1974	16	90,000	Contact stabilization	70% spray, 30% percolation	Unlined shell pits	12 wells
13	Boca Raton Wastewater Treatment Plant	1973	10	70,000	Contact stabilization	10% spray irrigation, 90% transported to ocean[2]	None	4 wells and 2 ditches
14	Tamarac Utility West	1969	5	35,000	Contact stabilization	90% spray irrigation, 10% percolation	Unlined percolation holding ponds	9 wells
15	City of Sunrise Utilities Plant	1975	8	30,000	Contact stabilization	Spray irrigation	Holding pond	6 wells

[1] Discontinued transport to Bay in October 1983; began spray irrigation in February 1983.
[2] Discontinued spraying in 1981.

Sampling Program

All samples of effluent from the treatment plants were collected after the final chlorination process. The effluent sampling locations are described in table 2. (Note--effluent at both the southeast and southwest spray fields at Tallahassee, plant number 3, was sampled.)

Table 2.--Description of effluent sampling locations

Plant No.	Station identification No.	Effluent sample location
1	302713086393001	End of dock in holding pond
2	302841086371901	In holding pond at pump uptake to spray field
[1]3a	302212084114492	In holding pond at pump uptake to spray field
[2]3b	302322084192001	Discharge pipe southeast of plant
4	294825081185501	In percolation pond at pump uptake to spray field
5	293227081122701	Effluent pipe in first tier of percolation pond
6	290942082045701	Drainage ditch connecting percolation pond
7	285152081401401	End of dock in percolation pond
8	283327081131101	In holding pond at pump uptake to spray field
9	282325081285401	At inflow to percolation pond
10	282223081354500	End of dock in holding pond
11	274740082443502	Discharge pipe
12	272736082372401	Near inflow at golf course pond
13	262200080063501	Discharge pipe
14	261213080153801	In percolation pond near pump to spray field
15	261013080153201	Pump station pond on golf course near pump to spray field

[1] Southeast spray field.
[2] Southwest spray field.

Ground-water samples were collected from existing monitoring wells at each treatment plant. The well selected for sampling was adjacent to and downgradient from the plant's percolation pond or spray field. Often, more than one monitoring well was available for sampling at a treatment plant. In

these cases, existing data for these plants were examined and the well with the greatest concentration of chloride and nitrate and greatest specific conductance was selected for sampling. A description of the ground-water monitoring wells sampled is given in table 3. At the Tallahassee plant, one monitoring well was sampled at each of the two spray fields.

Table 3.--Description of ground-water monitoring wells sampled

[P = PVC pipe; G = galvanized pipe]

Plant No.	Station identification No.	Local well No.	Diameter of well, in inches	Depth (feet)		Casing material	Location of well
				Bottom of well	To water surface		
1	302713086393002	5	4	22.7	5.70	P	In spray field, northeast of holding pond
2	302842086311902	2	1.5	55	.91	G	South edge of spray field, east of holding pond
[1]3a	302053084115101	SE-9	4	52	22.47	P	South edge of spray field
[2]3b	302314081190902	BOG-4-2	4	70	32.47	G	Center of southwest spray field
4	294825081185502	West	2	25.9	4.58	G	West edge of spray field
5	293227081122702	4	2	17.0	.12	P	East edge of pond
6	290942082045702	5	2	84.0	25.8	P	South edge of pond
7	285252081401402	B-6	2	14.8	3.98	G	West side of percolation pond
8	283327081131102	3	2	9.6	1.33	P	East edge of spray field
9	282325081285402	3	2	10.5	3.38	P	South edge of pond
10	282224081353401	Tree farm 17-S	2	9.6	2.19	P	750 feet east of irrigation site

[1] Southeast spray field.
[2] Southwest spray field.

Table 3.--Description of ground-water monitoring wells sampled--Continued

Plant No.	Station identification No.	Local well No.	Diameter of well, in inches	Depth (feet)		Casing material	Location of well
				Bottom of well	To water surface		
11	274829082405701	778	2	20.8	4.71	G	Edge of spray irrigation site
12	272736082372401	3	1.5	13.22	2.39	P	Edge of pond, southwest of facility
13	262200080063502	West	2	16.3	3.92	G	Near plant
14	261232080151802	USGS G2201	1.5	39.6	6.94	P	20 feet west of percolation pond
15	261038080154602	G2193	1.5	42.0	8.91	P	37 feet west of pump station pond

The reconnaissance was made in two sampling phases. The first phase (phase I) was conducted from April through August 1983. During phase I, the effluent at the 15 plants was analyzed for several major groups of organic compounds which included volatile compounds, base/neutral-extractable compounds, acid-extractable compounds, organophosphorus insecticides, organochlorine insecticides and related compounds, polychlorinated biphenyl compounds (PCB), and the gross organic indicator, total organic carbon (TOC) (table 4). The results of the phase I analyses were used to evaluate which specific compounds, within each group of major compounds, were present in the various plant effluents, and, therefore, potentially present in the ground water near the area of disposal.

During phase II (October 1983 through May 1984), the effluent and water from a representative monitoring well at each plant was sampled. The analytical coverage for phase II was limited to only the groups of organic compounds which included those specific compounds detected in the plant effluent during phase I. For example, if only chloroform was detected in the effluent from a plant during phase I, then chemical analyses of phase II (effluent and ground water) were limited to volatile organic compounds.

Table 4.--Groups of organic compounds and minimum detection limits

[Parameter code is an identifier of analytical data in the U.S. Geological Survey water data storage and retrieval data management system]

Parameter code	Compound	Minimum detection limit (µg/L)
	Organochlorine insecticides and related compounds, total recoverable	
39330	Aldrin	0.01
39350	Chlordane	.1
39360	p,p'-DDD	.01
39365	p,p'-DDE	.01
39370	p,p'-DDT	.01
39380	Dieldrin	.01
39388	Endosulfan	.01
39390	Endrin	.01
39516	Gross polychlorinated biphenyls	.1
39250	Gross polychlorinated naphthalenes	.1
39410	Heptachlor	.01
39420	Heptachlor epoxide	.01
39340	Lindane	.01
39480	Methoxychlor	.01
39755	Mirex	.01
39034	Perthane	.1
39400	Toxaphene	1.0
	Organophosphorus insecticides, total recoverable	
39570	Diazinon	.01
39398	Ethion	.01
39530	Malathion	.01
39600	Methyl parathion	.01
39790	Methyl trithion	.01
39540	Parathion (ethyl)	.01
39786	Trithion	.01

Table 4.--Groups of organic compounds and minimum detection limits--Continued

Parameter code	Compound	Minimum detection limit (µg/L)
	Volatile organic compounds (purgeable), total recoverable	
34030	Benzene	3.0
32104	Bromoform	3.0
32102	Carbon tetrachloride	3.0
34301	Chlorobenzene	3.0
34311	Chloroethane	3.0
34576	2-Chloroethyl vinyl ether	3.0
32106	Chloroform	3.0
32105	Dibromochloromethane	3.0
32101	Dichlorobromomethane	3.0
34496	1,1-Dichloroethane	3.0
32103	1,2-Dichloroethane	3.0
34501	1,1-Dichloroethylene	3.0
34546	1,2-trans-Dichloroethylene	3.0
34541	1,2-Dichloropropane	3.0
34561	1,3-Dichloropropene	3.0
34371	Ethylbenzene	3.0
34413	Methyl bromide	3.0
34423	Methylene chloride	3.0
34516	1,1,2,2-Tetrachloroethane	3.0
34475	Tetrachloroethylene	3.0
34010	Toluene	3.0
34506	1,1,1-Trichloroethane	3.0
34511	1,1,2-Trichloroethane	3.0
39180	Trichloroethylene	3.0
39175	Vinyl chloride	3.0
	Base/neutral-extractable compounds, total recoverable	
34205	Acenaphthene	5.0
34200	Acenaphthylene	5.0
34220	Anthracene	5.0
34526	Benz(a)anthracene	10.0
34230	Benzo(b)fluoranthene	10.0

Table 4.--Groups of organic compounds and minimum detection limits--Continued

Parameter code	Compound	Minimum detection limit (µg/L)
34242	Benzo(k)fluoranthene	10.0
34521	Benzo(g,h,i)perylene	10.0
34247	Benzo(a)pyrene	10.0
34636	4-Bromophenyl phenyl ether	5.0
34292	Butylbenzyl phthalate	5.0
34278	Bis(2-chloroethoxy)methane	5.0
34273	Bis(2-chloroethyl)ether	5.0
34283	Bis(2-chloroisopropyl)ether	5.0
34581	2-Chloronaphthalene	5.0
34641	4-Chlorophenyl phenyl ether	5.0
34320	Chrysene	10.0
34556	Dibenzo(a,h)anthracene	10.0
34536	1,2-Dichlorobenzene	5.0
34566	1,3-Dichlorobenzene	5.0
34571	1,4-Dichlorobenzene	5.0
34336	Diethylphthalate	5.0
34341	Dimethylphthalate	5.0
39110	Di-n-butyl phthalate	5.0
34611	2,4-Dinitrotoluene	5.0
34626	2,6-Dinitrotoluene	5.0
34596	Di-n-octyl phthalate	10.0
39100	Bis(2-ethylhexyl)phthalate	5.0
34376	Fluoranthene	5.0
34381	Fluorene	5.0
39700	Hexachlorobenzene	5.0
39702	Hexachlorobutadiene	5.0
34386	Hexachlorocyclopentadiene	5.0
34396	Hexachloroethane	5.0
34403	Indeno(1,2,3-cd)pyrene	10.0
34408	Isophorone	5.0
34696	Naphthalene	5.0
34447	Nitrobenzene	5.0
34438	N-Nitrosodimethylamine	5.0
34428	N-Nitrosodi-N-propylamine	5.0
34433	N-Nitrosodiphenylamine	5.0

Table 4.--Groups of organic compounds and minimum detection limits--Continued

Parameter code	Compound	Minimum detection limit (µg/L)
34461	Phenanthrene	5.0
34469	Pyrene	5.0
34551	1,2,4-Trichlorobenzene	5.0
	Acid-extractable compounds, total recoverable	
34452	4-Chloro-3-methylphenol	30.0
34586	2-Chlorophenol	5.0
34601	2,4-Dichlorophenol	5.0
34606	2,4-Dimethylphenol	5.0
34657	4,6-Dinitro-2-methylphenol	30.0
34616	2,4-Dinitrophenol	20.0
34591	2-Nitrophenol	5.0
34646	4-Nitrophenol	30.0
39032	Pentachlorophenol	30.0
34694	Phenol	5.0
34621	2,4,6-Trichlorophenol	20.0
	Other	
00680	Carbon, organic, total	0.1 mg/L

Sampling Procedures

Effluent and ground-water samples analyzed for organic compounds were collected to assure that the sample came in contact only with Teflon[1], stainless steel, or glass. The use of these materials reduced the possibility of contact with plastics, organic glues and solvents, and other types of materials that might bias the concentration of organic contaminants in the sample. However, many of the wells sampled were cased with polyvinylchloride (PVC) pipe from which organic glues and solvents, and plasticizers containing phthalates may be leached.

The effluent samples from the holding pond, percolation pond, or discharge pipe were "grab samples," collected by dipping a stainless steel collection container, that had been cleaned and rinsed with reagent-grade methanol and organic-free water, directly into the effluent.

[1] Use of the brand name Teflon in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

The samples to be analyzed for organic compounds other than the volatile compounds were transferred directly into glass containers with Teflon-lined screw caps. The effluent samples for volatile compounds were collected in duplicate by inserting a 40-milliliter (mL) glass vial into a displacement sampler that was lowered through the water column, and by flushing the vial three times with sample water before collecting a sample. The sample was then brought near the water surface and capped underwater with Teflon-lined screw caps. This technique reduced the possibility of volatilization of the volatile gases during the collection procedure.

For ground-water samples, three to five casing volumes of well water were purged from the well prior to sampling by using a centrifugal or submersible pump. All samples, except volatiles, were collected by pumping through Teflon tubing and a Teflon stopper directly into the glass collection bottle. Samples for volatile compounds were collected using a Teflon bailer and transferred to two 40-mL septum vials. All samples for organic analyses, except TOC, were chilled to 4°C immediately after collection and shipped by a 24-hour delivery service to the U.S. Geological Survey National Water-Quality Laboratory-Atlanta, in Doraville, Ga. Samples for TOC analysis were chilled to 4°C and shipped to the U.S. Geological Survey Water-Quality Service Unit in Ocala, Fla. Samples collected for volatile compounds during the second phase of sampling were treated with sodium thiosulfate to minimize the reaction of chlorine with naturally occurring organics to form halogenated compounds. It is noted that a comparability analysis between the untreated and treated procedures was not made. All bottles and glassware used in the study were cleaned in the laboratory according to quality assurance procedures described by Friedman and Erdmann (1982, p. 21).

Analytical Methods

Samples were analyzed in the U.S. Geological Survey Laboratories in Doraville, Ga., and Ocala, Fla., for the organic constituents listed in table 4 using methods described in Wershaw and others (1983).

During phase I, base/neutral- and acid-extractable (BNA) compounds were detected by flame ionization detector (FID), or mass spectrometer (MS) detector, following gas chromatography (GC) separation. BNA sample extracts from plants 1, 2, 3, 4, 8, 9, and 10 were screened for the presence of organic compounds using GC/FID. Specific compounds were not identified by the FID, but their presence was indicated and approximate concentrations of detected compounds were calculated. If the total concentration of organic compounds detected by the FID in an effluent sample from phase I was estimated to be greater than 100 µg/L, GC/MS analyses were performed on samples from the effluent and ground water from that plant during phase II.

BNA sample extracts from plants 5, 6, 7, 11, 12, 13, 14, and 15 were analyzed by GC/MS with no prior FID screening. Organic compounds detected were individually identified and quantified, but identifications by the MS detector were limited to those listed in table 4 as BNA extractable.

U.S. Geological Survey procedures for laboratory quality assurance are described in Friedman and Erdmann (1982). Additional procedures specific to each method are described in Wershaw and others (1983). The laboratory participates in the U.S. Environmental Protection Agency (EPA) Quality Assurance Performance Evaluation Program, the U.S. Geological Survey Standard Reference Water Sample Program, the U.S. Geological Survey Florida District Quality Assurance Program, and the U.S. Geological Survey Blind Sample Program.

Field sampling quality assurance procedures included the collection of field blanks and duplicate samples. General quality assurance procedures used for field sampling are found in U.S. Environmental Protection Agency (1982) and Friedman and Erdmann (1982).

RESULTS

A summary of the analytical results of specific organic compounds that were detected in the effluent and monitoring well at each of the 15 treatment plants during both phase I and II is given in table 5.

Table 5.--Summary of organic compounds detected

[Concentrations are total recoverable in micrograms per liter, except as indicated; mg/L = milligrams per liter; ND = concentrations below analytical detection; -- = no data]

Plant No.	Compounds detected	Effluent (Date sampled)		Well (Date sampled)
1		7/13/83	11/22/83	11/22/83
	Diazinon	[a] 0.20	[b] 0.21	[b] 0.01
	Dieldrin	[a] .08	ND	ND
	Lindane	[a] ND	.02	ND
	Chloroform	13	[c] --	[d] 4.5
	Organic carbon, total (mg/L)	14	7.5	32
2		7/12/83	11/21/83	11/21/83
	Diazinon	.48	[e] .21	[e] ND
	Malathion	.23	[e] ND	[e] ND
	Lindane	1.0	.04	ND
	Chloroform	4.8	[c] --	ND
	Organic carbon, total (mg/L)	21	7	6
3 (Southeast spray field)		5/27/83	10/6/83	10/6/83
	Diazinon	.29	.33	ND
	Malathion	ND	.02	ND
	Lindane	.03	.05	ND
	Trichloroethylene	5.0	ND	ND
	Bis(2-ethylhexyl)phthalate	290	ND	ND
	Organic carbon, total (mg/L)	14	8.3	1.5

See footnotes at end of table.

Table 5.--Summary of organic compounds detected--Continued

Plant No.	Compounds detected	Effluent (Date sampled)		Well (Date sampled)
3	(Southwest spray field)			
	Diazinon	--	.66	ND
	Malathion	--	.03	ND
	Organic carbon, total (mg/L)		9.1	1.2
4		6/23/83	10/27/83	10/27/83
	Diazinon	.06	.03	.03
	Methyl parathion	ND	ND	.01
	Organic carbon, total (mg/L)	10	9.6	45
5		6/24/83	10/27/83	10/27/83
	Lindane	.02	ND	ND
	Chloroform	110	ND	ND
	Dichlorobromomethane	10	ND	ND
	Organic carbon, total (mg/L)	11	17	35
6		4/18/83	11/9/83	11/9/83
	Diazinon	.66	.03	ND
	Malathion	ND	.02	ND
	Lindane	.16	ND	ND
	Chloroform	6.0	5.2	ND
	Butyl benzyl phthalate	36	ND	ND
	Organic carbon, total (mg/L)	14	8.6	.4
7		8/2/83	11/9/83	11/9/83
	Diazinon	.33	.12	ND
	Ethion	.04	.04	ND
	Dieldrin	.03	ND	ND
	Lindane	ND	.11	ND
	Gross PCB	ND	.7	ND
	Organic carbon, total (mg/L)	35	5.5	3.3
8		6/8/83	10/13/83	10/13/83
	Chloroform	17	28	ND
	Organic carbon, total (mg/L)	7.3	7	62
9		6/7/83	10/13/83	10/13/83
	Chloroform	41	ND	12
	Dichlorobromomethane	8.0	ND	ND
	Organic carbon, total (mg/L)	4.6	8.3	12
10		6/6/83	10/12/83	10/12/83
	Diazinon	.09	.07	ND
	Chloroform	19	9.1	29
	Organic carbon, total (mg/L)	17	12	27

See footnotes at end of table.

Table 5.--Summary of organic compounds detected--Continued

Plant No.	Compounds detected	Effluent (Date sampled)		Well (Date sampled)
11		4/19/83	[g]12/9/83	12/9/83
	Diazinon	.08	[h] --	[h] --
	Lindane	.03	ND	ND
	Heptachlor	.02	ND	ND
	Heptachlor epoxide	ND	.02	ND
	Bromoform	[i]40	ND	ND
	Dibromochloromethane	[i]45	ND	ND
	Chloroform	[i] ND	5.0	ND
	Dichlorobromomethane	[i]28	ND	ND
	Bis(2-ethylhexyl)phthalate	7	--	--
	Organic carbon, total (mg/L)	11	15	2.1
12		4/20/83	12/9/83	12/9/83
	Diazinon	.50	ND	[h] --
	Malathion	.06	ND	[h] --
	Lindane	.03	.01	ND
	Organic carbon, total (mg/L)	21	9.1	9.5
13		8/4/83	[g]12/8/83	12/8/83
	Diazinon	.38	ND	ND
	Chloroform	8.0	ND	ND
	Organic carbon, total (mg/L)	12	13	80
14		8/3/83	12/7/83	12/7/83
	Diazinon	.21	.11	.01
	Malathion	ND	.01	ND
	Chloroform	5.0	6.0	ND
	Tetrachloroethylene	ND	9.0	ND
	Trichloroethylene	ND	ND	5.0
	Organic carbon, total (mg/L)	10	12	7.1
15		8/3/83	12/7/83	12/7/83
	Diazinon	.08	1.5	ND
	Chloroform	ND	11	ND
	Organic carbon, total (mg/L)	11	13	13

[a] Result reflects dissolved constituents rather than total.
[b] Organophosphorus insecticide sample was collected 2/21/84.
[c] No volatile sample was collected.
[d] Volatile sample was collected 5/9/84.
[e] Organophosphorus insecticide sample was collected 2/22/84.
[f] Volatile sample was collected 8/1/83.
[g] Different effluent site.
[h] Organophosphorus insecticide analysis deleted due to sulfur interference.
[i] Volatile sample was collected 8/5/83.

To illustrate the general distribution, the occurrence of the six most commonly detected organic compounds in treatment-plant effluent (in one or both samples) is shown in figure 2. This overview suggests that selected organophosphorus, organochlorine, and volatile compounds were rather ubiquitous. For instance, diazinon was detected in the effluent at 12 plants, and malathion was detected at 5 plants. The organochlorine insecticide, lindane, was found at 8 plants, and the effluent at 11 plants contained detectable concentrations of the volatile compound, chloroform.

An explanatory note regarding the approach to data enumeration for the following presentation of results is provided. Specific organic compounds, for example, volatiles and organophosphorus insecticides, are arranged in groups primarily on the basis of analytical method. Many samples collected during this reconnaissance had more than one specific compound within a group present in detectable concentrations. For example, diazinon and malathion, in the organophosphorus insecticide group, were detected in several effluent samples. Therefore, in order to simplify the presentation of these data, the sum of all the specific compounds for each group of organic compounds for a sample was determined. This collective concentration for a sample is referred to as the "aggregate concentration" for that group. Mean aggregate concentration is the average of the collective sums of all specific compounds for a group for the two effluent samples at each plant.

Additionally, statistical liberty was taken in preparing the following illustrations (1) by assigning a 0 µg/L concentration to censored data (data reported as concentrations below analytical detection), and (2) in referring to the aggregate concentration of a single sample of well water as a mean.

Distribution of Organic Compounds in Treatment Plant Effluent

The distribution by ranges of mean aggregate concentrations of volatile and insecticide compounds in the effluent at the 15 plants is shown in figures 3 and 4, respectively.

Volatile organic compounds were detected in the effluent at 12 of 16 sampling locations at the 15 plants (fig. 3). Chloroform was the most common, occurring at 11 plants. The greatest average aggregate concentrations were 60 and 59 µg/L, respectively, at plant 5 (Palm Coast Utility Corporation) and plant 11 (St. Petersburg Northwest No. 3 Wastewater Plant). Both plants, however, indicated a large two-sample range in aggregate concentration and specific composition. For example, the aggregate concentration of effluent at plant 5 ranged from 120 µg/L (110 µg/L chloroform and 10 µg/L dichlorobromomethane) in the June 1983 sample to none detected in the October 1983 sample; at plant 11, the aggregate concentration ranged from 113 µg/L (40 µg/L bromoform, 45 µg/L dibromochloromethane, and 28 µg/L dichlorobromomethane) in August 1983 to 5 µg/L of chloroform in December 1983. The mean aggregate concentrations of volatile organic compounds detected at the other 10 plants were 25 µg/L or less. No volatile compounds were detected at plant 4 (St. Augustine Shores Wastewater Treatment Plant), plant 7 (Eustis Sewage Plant), and plant 12 (Southwest Regional Treatment Plant, Bradenton).

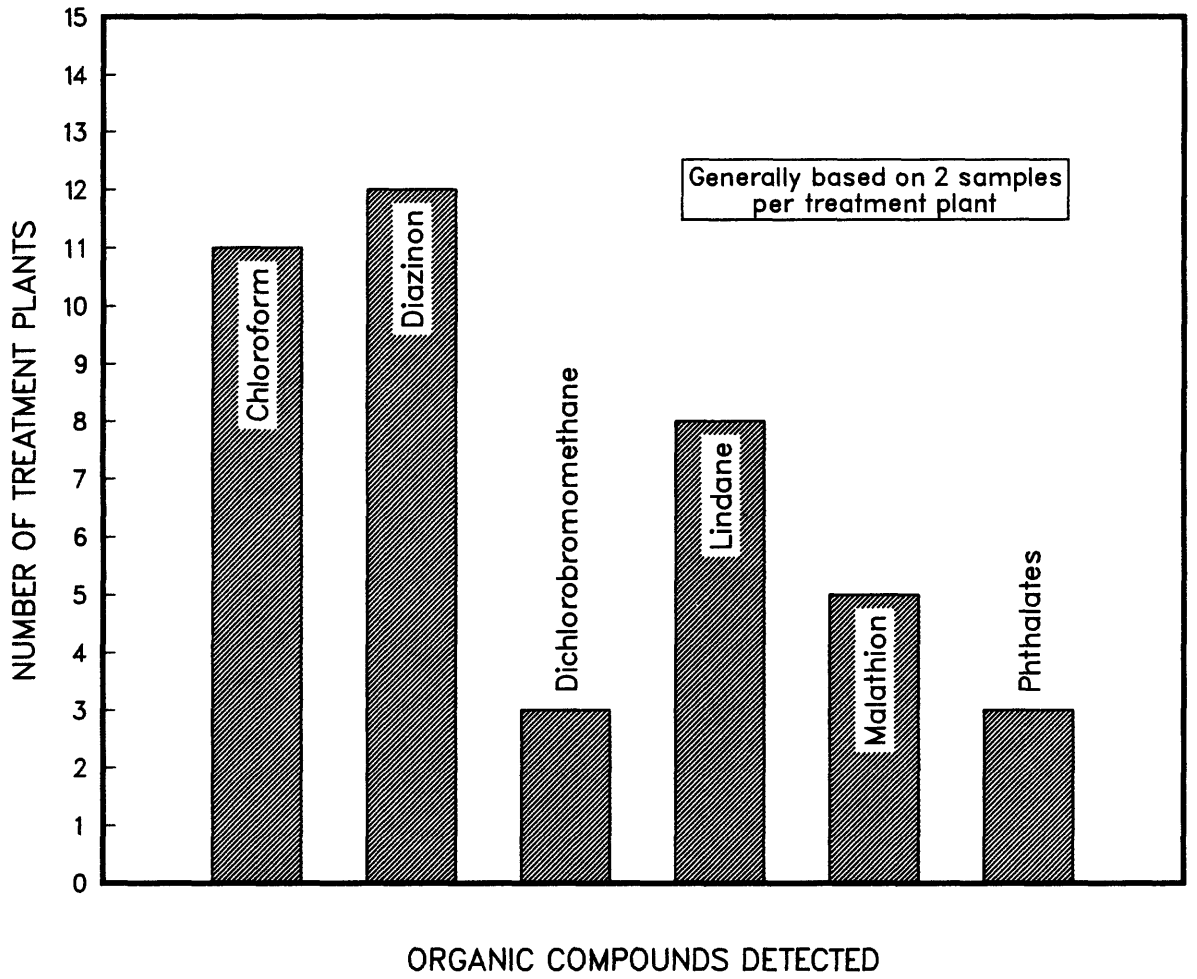

Figure 2.--Occurrence of specific organic compounds commonly detected in effluent at 15 treatment plants.

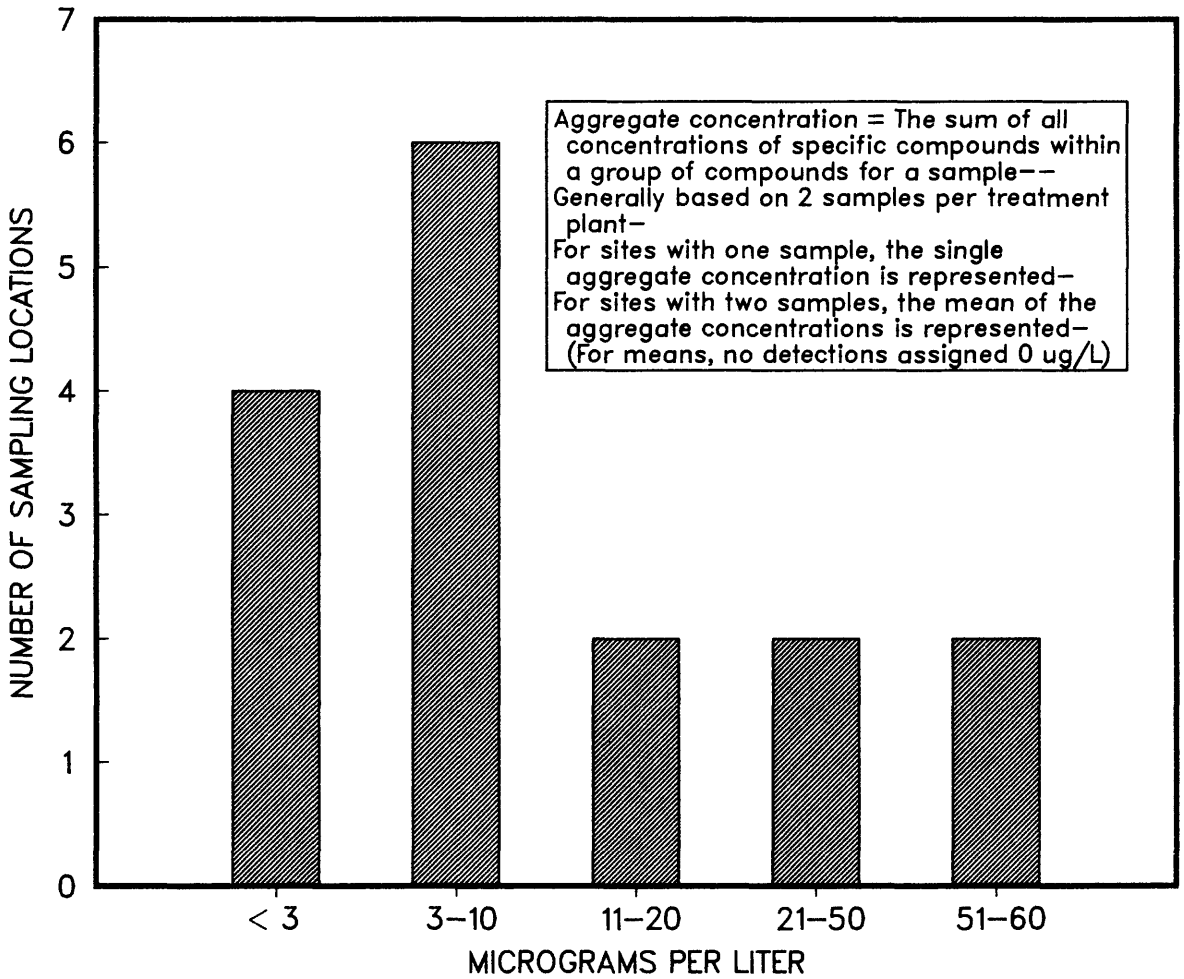

Figure 3.--Ranges of mean aggregate concentrations of volatile organic compounds in effluent at 16 sampling locations. (Plant 3 has two sampling locations.)

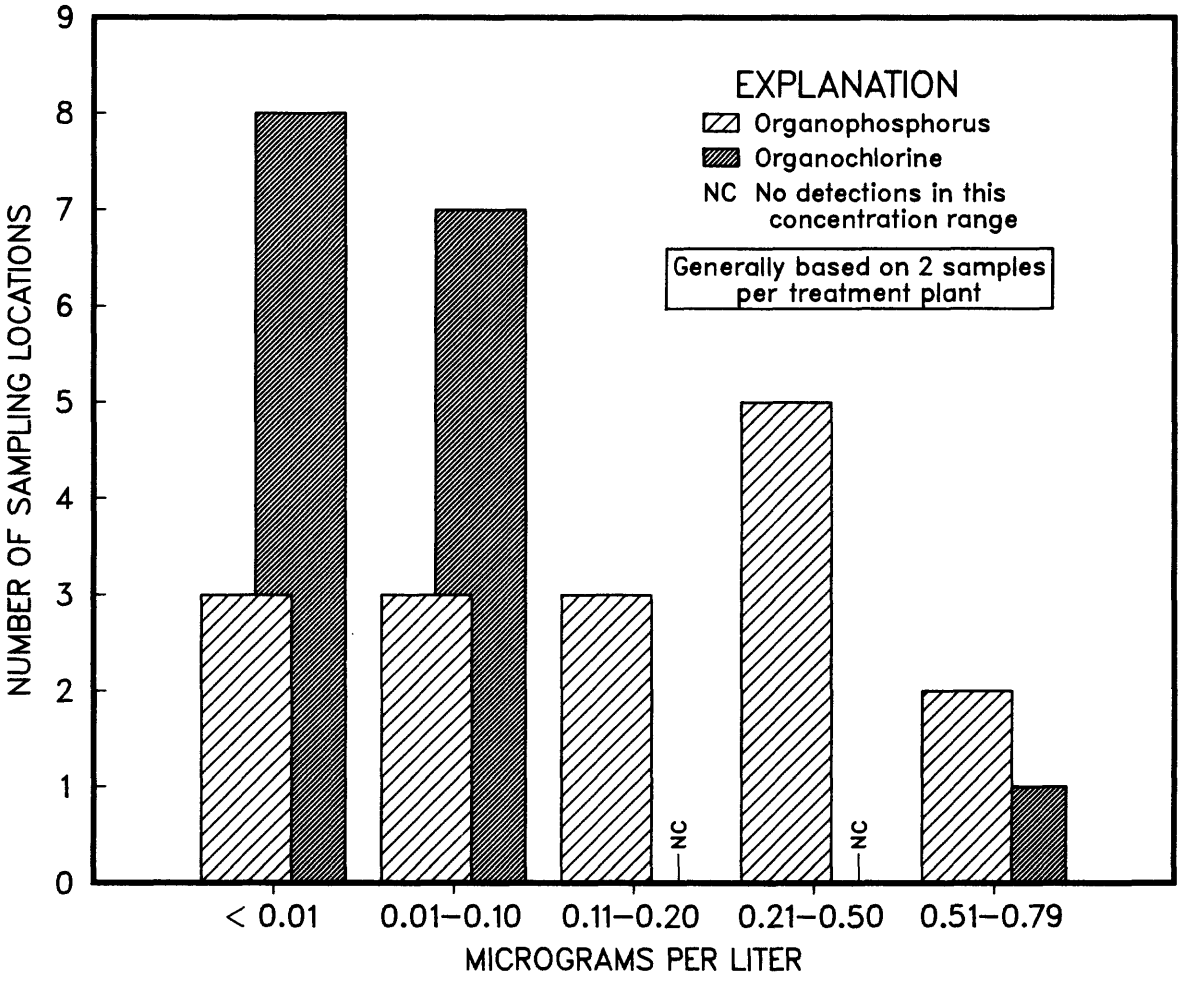

Figure 4.--Ranges of mean aggregate concentrations of two insecticide groups in effluent at 16 sampling locations. (Plant 3 has two sampling locations.)

The concentrations of organophosphorus insecticides and organochlorine compounds in the effluent and in water from the associated monitor well at selected treatment plants are shown in figures 6 and 7. (Note--data for some monitoring wells were not available.) The water from only three monitor wells indicated organophosphorus insecticides above detection limits, and organochlorine insecticides were not detected.

The data collected during this reconnaissance indicated that numerous organic contaminants (primarily chloroform, diazinon, lindane, and malathion) were common in the effluent from treatment plants. These same contaminants, however, were not commonly detected in water from associated monitor wells. These results suggest that at many plants the organic contaminants may have been altered or retained during the spreading or percolation process. However, this conjecture is based on a very limited sampling, and it is also noted that four monitor wells indicated detectable concentrations of either chloroform or trichloroethylene, and three indicated detectable diazinon concentrations.

SUMMARY

A reconnaissance sampling of selected organic compounds in effluent and shallow ground water at 15 municipal wastewater treatment plants in Florida that use land application disposal methods was conducted from April 1983 through May 1984. The scope of the reconnaissance included collecting one or two effluent samples and one sample of ground water from a nearby monitor well at each plant. The primary purpose of the reconnaissance was to determine the identity and concentration of specific organic contaminants in effluent and local ground water, and to assess if the organic contaminants of the effluent appear to have contributed to contamination of ground water in the immediate vicinity of the wastewater disposal plants.

Analytical results of 2 effluent samples from the 15 plants indicated trace concentrations of volatile organic compounds (predominantly chloroform) at 12 of the 15 plants. It is likely that the presence of chloroform in the effluent was the result of chlorination. The maximum aggregate concentration of volatile organic compounds was 120 µg/L (110 µg/L chloroform and 10 µg/L dichlorobromomethane) in an effluent sample collected in June 1983 at plant 5 (Palm Coast Utilities Corporation); however, no volatile organic compounds were detected in a second effluent sample collected in October 1983. Most effluent samples collected at the other plants indicated volatile organic compounds below 50 µg/L, and three plants indicated no detectable volatile organic compounds.

Organophosphorus insecticides were detected in the effluent at 12 of the 15 plants and organochlorine compounds were detected at 8 of the 15 plants. The predominant organophosphorus compounds detected were the widely used household insecticides, diazinon and malathion. The maximum organophosphorus concentration of 1.5 µg/L (diazinon) was detected in the effluent sample collected at plant 15 (City of Sunrise Utilities Plant) in December 1983. Lindane was the most commonly occurring organochlorine insecticide, and the maximum concentration was 1.0 µg/L detected in an effluent sample collected at plant 2 (Garnier Beach Sewage Treatment Plant) in July 1983.

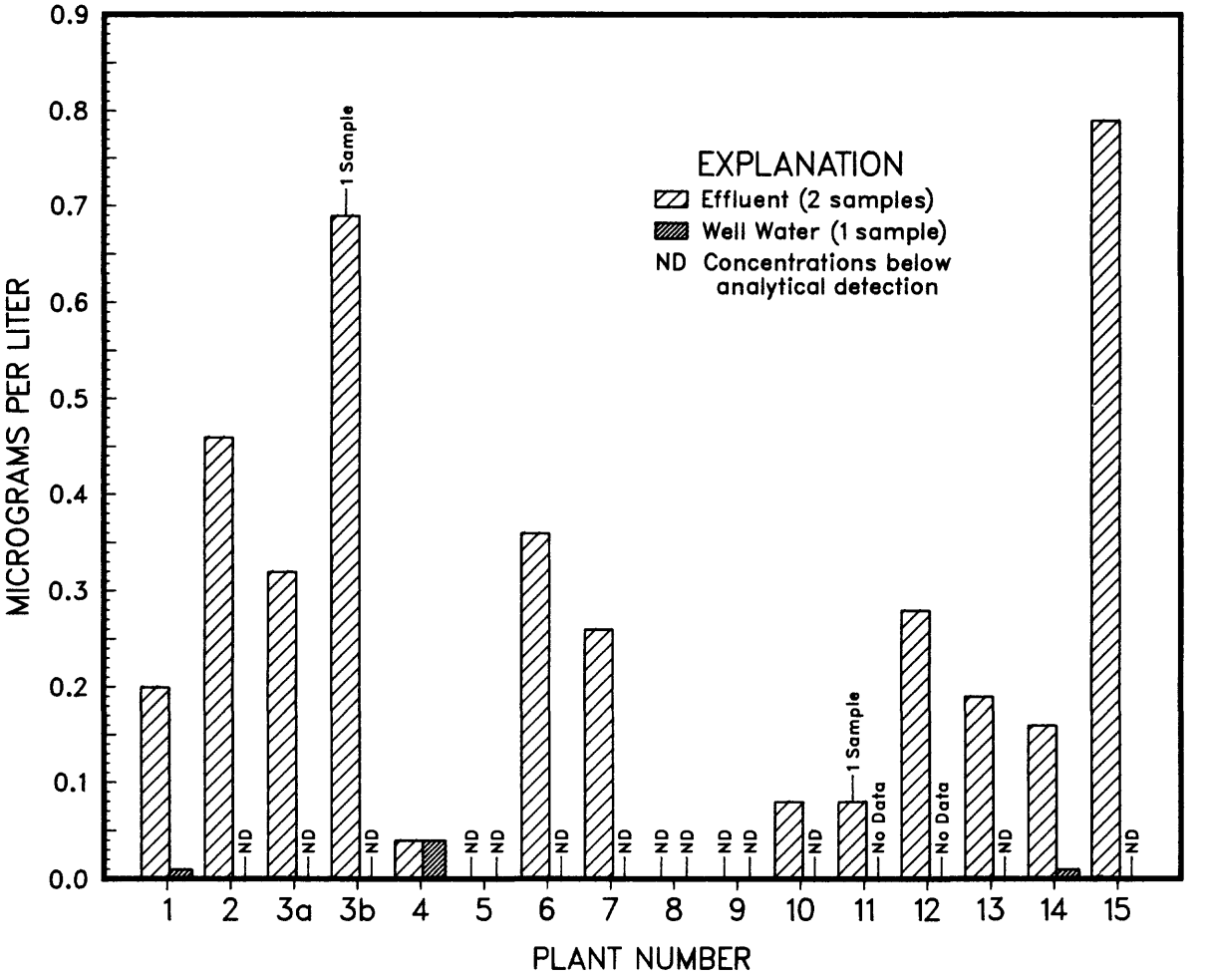

Figure 6.--Mean aggregate concentrations of organophosphorus insecticides in effluent and monitor well at 15 plants.

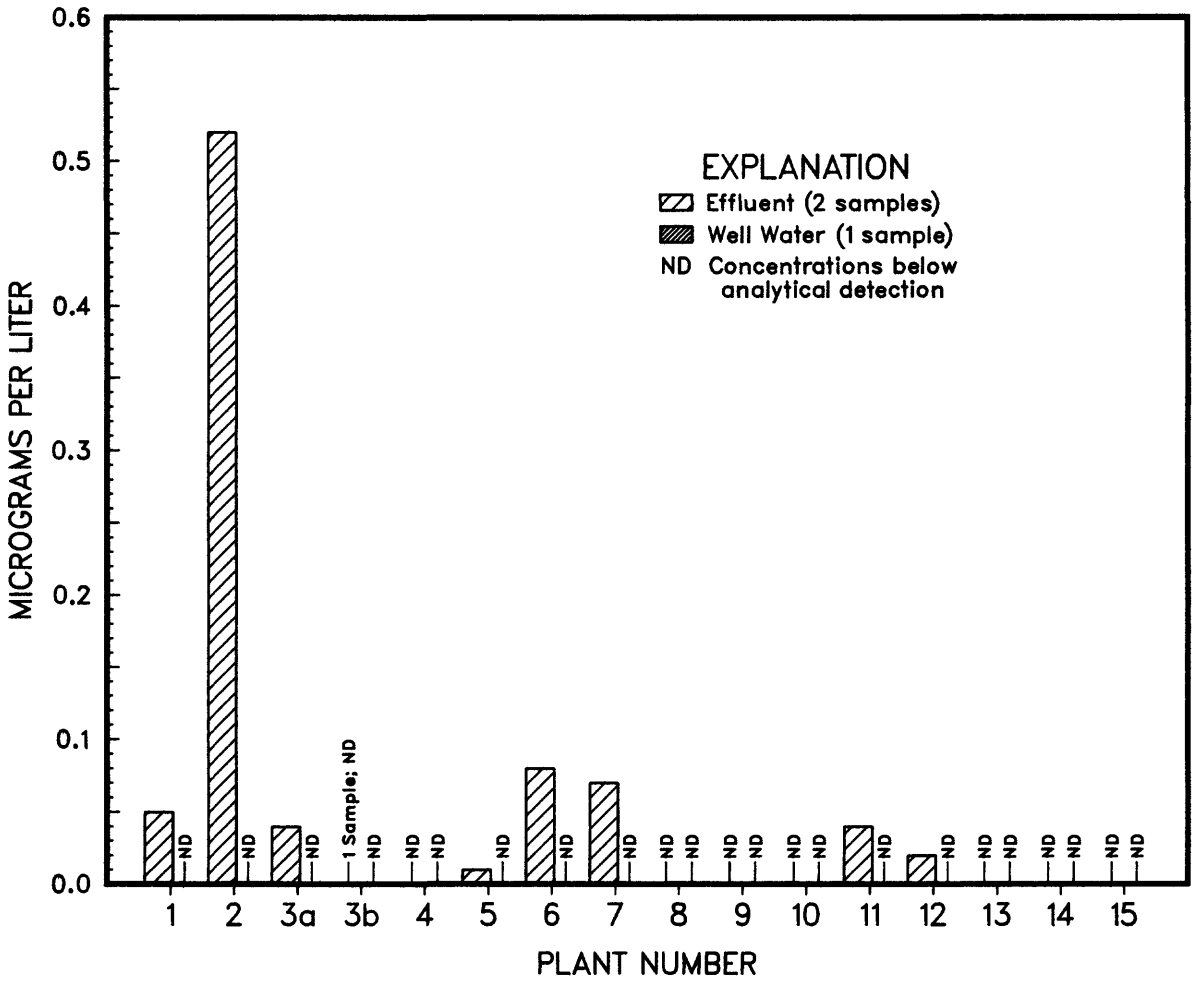

Figure 7.--Mean aggregate concentrations of organochlorine compounds in effluent and monitor well at 15 plants.

Detectable concentrations of volatile organic compounds and organophosphorus insecticides were present in water from only a few monitoring wells. Organochlorine insecticides were not detected in any samples from the monitoring wells. The general absence of organic contaminants in the water samples collected from monitor wells suggests that the few volatile and insecticides compounds commonly found in the effluent of the treatment plants are not percolating into local ground water at many plants. This observation, however, is based on very limited data, and it is also noted that a few monitor wells did indicate the presence of organic contaminants.

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